Vehicle Air Dam System

Technical Field

The invention relates generally to the field of over-the-road vehicles and more particularly to vehicle components directed at reducing the aerodynamic drag of over-the-road vehicles.

Background

Fuel efficiency is of increasing importance to the operation of land vehicles in light of rising fuel prices and ecological concerns. This is especially true in the field of over-the-road highway trucks. These trucks travel great distances at relatively high speeds. Any improvement that reduces the aerodynamic drag on the truck at highway speeds can have a significant impact on the fuel economy of the truck.

Typically, over-the-highway trucks include a number of body components aimed at reducing drag and improving fuel economy. For example, some trucks have fairings installed above the roof of the cab to direct air more smoothly over the transition between the cab and the trailer. The design of hoods and fenders focuses on creating an aerodynamic surface. Another component that is often used to reduce drag is the air dam, which is a deflective shield installed between the frame of the truck and the ground. An air dam routes air around the truck's bottom smoothly to improve aerodynamic performance. Most air dams are constructed of relatively rigid materials that can be cracked or damaged by uneven road surfaces that may be found on parking lots and surface roads. Because of the potential for damage, additional clearance between the air dam and the ground may be necessary at the expense of the air dam's performance at highway speed on smooth road surfaces.

Summary

An air dam that is made of flexible cells installed adjacent to one another is capable of installation in many deflecting configurations on a vehicle and can also deflect under impact.

In one exemplary air dam system described herein, the air dam system is capable of being deployed at higher speeds while being stowed under the frame of the truck when the truck is operating on rough road surfaces to reduce the potential for air dam damage. The air dam system can be actuated pneumatically and when deployed tends to reduce aerodynamic drag byaltering the path of airflow under and/or immediately around a vehicle. Other methods of actuation such as hydraulic or mechanical components may also be used with the air dam system. The air dam system may be designed into future production vehicles or added to an existing vehicle as a retrofit device. While targeted to the "over the road" Class 8 truck market, the device is equally applicable to virtually all modes of ground transportation.

The exemplary pneumatic air dam system consists of multiple flexible hollow or inflated structures in various geometric forms having cross sectional shapes such as circles, ovals, rectangles, and trapezoids and a height of sufficient length to span from the truck's underside to just above the ground. These structures are herein referred to as cells, and for the purposes of this description each cell has a circular cross section of approximate four inches in diameter and is approximately nine inches long. To form the air dam system, multiple cells are placed together with each cell's long edge abutted to the next cell's long edge to form a continuous barrier. Each cell is made of an internal inflatable bladder and/or a flexible impact resistant sheath. Since the cell is flexible, significant impacts will cause the cell to deflect, such as when the cell makes contact with debris on the paved surface over which the vehicle is traveling. In such an impact situation, the cell, upon removal of the deflecting force, returns to its pre-deflected state and position.

According to one embodiment, the cells are inflatable bladders that are selectively deployable. When the bladder is filled with air, the cell becomes more rigid so that the cell will not deflect under the pressure of air moving at velocities typically encountered in a vehicle traveling on a paved surface. When the air dam system is not activated, the deflated cells are lifted up toward the undercarriage of the truck such that the deflated cell is removed from general sight and impact. A spring steel wire is contained in the sleeve to provide a retracting force to lift

the deflated cell when the air dam system is not activated. The spring steel lifting force is overcome when the system is active.

In alternative embodiments, the air dam system cells can include only an inflated bladder or a flexible sleeve. The inflated cell may or may not be enclosed in a flexible sleeve. By removing the pneumatic actuation feature, the need for air channels within the mounting structure is eliminated. An air dam system that includes cells that are either inflated bladders or flexible sleeves retains benefits such as the ease of placing the cells in a variety of configurations and the deflection under impact while simplifying the design.

Brief Description of the Drawings

Figure 1 is a perspective overview of an over-the-highway truck that includes an air dam system constructed to one embodiment of the present invention;

Figure 2 is a side view of the truck of Figure 1;

Figure 3 is a view from below the truck of Figure 1;

Figures 4 and 5 are cross sectional views of an air dam cell constructed in accordance with an embodiment of the present invention;

Figure 6 and 7 are cross sectional views of an air dam cell constructed in accordance with an alternative embodiment of the present invention;

Figure 8 is a cut away view of an air dam cell support and mounting structure constructed in accordance with an embodiment of the present invention;

Figure 9 is a cross sectional view of the air dam cell support and mounting structure of Figure 8;

Figure 10 is a cross sectional view of the air dam cell support and mounting structure of Figure 8 taken orthogonally to the view of Figure 9;

Figure 11 is a cross sectional view of an air dam cell constructed in accordance with an embodiment of the present invention;

Figure 12 is a cross sectional view of an air dam cell constructed in accordance with an embodiment of the present invention; and

Figure 13 is a top view of a trailer that includes an air dam constructed in accordance with an embodiment of the present invention.

Description

Figures 1, 2, and 3 provide an overall view of the air dam system installed on a class 8 truck tractor 10. It is believed that installing a trailer air dam system 53 on the trailer 14 as shown in Figure 13 will provide additional wind resistance benefits. The illustrated air dam system includes under-carriage and front cell banks 20, 25 that each consist of a row of abutting cells 30 as will be described below. In practice, the cells 30 are suspended from the underside of the truck frame 15 such that, for example, the four inch diameter sections are attached to a mounting structure that is fixed to the frame 15 and the nine inch lengths extend down toward the ground. When aligned in this manner, the cells form a barrier blocking the primary flow of air under and/or immediately around the vehicle. Figure 2 shows a side view of the cells installed on a truck with GC indicating the air gap filled by the cells when inflated. Figure 3 shows the typical spatial placement left to right and the resultant air path blockage created by the inflation of the cells. Blocking the primary flow of air under the vehicle causes a reduction in the drag created by air turbulence under the carriage of the vehicle and has the resultant effect of improving fuel efficiency.

Figure 3 shows the typical cell locations with respect to the vehicle frame. The cells can be positioned in a front bank 25 or an under-carriage bank 20, or around the entire periphery of the vehicle, or any combination or subsections of these locations with varying levels of air flow restriction. The cells may also be located around the front of a trailer, around the entire trailer, and any combination or subsections of these locations, again, with varying levels of air flow restriction.

Figure 4 shows a first embodiment of an air dam cell 30 in its inflated condition and illustrates the basic cell components: an impact resistant sleeve 39; an inflatable bladder 37, which resides within, and is restrained by, the sleeve; and a spring steel wire 36. Figure 5 shows a deflated cell in its home, curled upward, position. The upward curl is caused by the spring steel wire 36, which in its natural state is bent into a "U" shape. The sleeve 39 has additional lengths of material in the front and back of the cell. The extra sleeve material is permanently sandwiched between two malleable strips 32, typically formed of metal, in the front and back of the cell diameter, 180 degrees apart. The malleable strip 32 has mounting tabs where the malleable strip is to be mounted to the frame of the vehicle. Each malleable strip consists of multiple cells mounted side by side, the number of cells being determined by the spatial coverage required.

The cells are made rigid pneumatically. Utilizing low pressure, low volume air, cells are interconnected by small diameter pneumatic tubing 34. Typically, no more than four cells will be interconnected thereby minimizing the potential for complete loss of air pressure should one cell malfunction. The malleable strips are designed to be modular such that strips may be replaced as needed or placed individually for location optimization.

Figures 6-9 illustrate an alternative embodiment of the pneumatic air dam system. Each cell 50 is made up of an impact resistant sleeve 53, that can be made of 60 durometer silicon rubber, that surrounds an inflatable bladder 55. The spring steel wire 51, or alternatively an expandable joint, which in its natural state has a "U" shape, is inserted into a channel 54 on the sleeve 53. The spring 51 causes the cell 50 to curl upward when the bladder is not inflated as shown in Figure 7. Each cell is pressed onto a nipple 42 that is part of a supporting rail 41 or rails (Figures 8-10) that is mounted to the underside of the truck in locations in which the air dam system is to be installed. Each rail 41 holds multiple cells mounted side by side, the number of cells being determined by the spatial coverage required. For example, in a typical system the each side of the bullet shaped deflector has a 7 foot long straight section holding about 19 cells mounted to the truck fairing (not shown) and the arcuate section mounts about another 20 cells. One or more mounting points on the arcuate portion of the rail are fixed to the truck frame.

The cells are pushed onto the nipple 42 and may be locked into position by barbs (shown as 94 in Figure 11) or other friction enhancing features on the nipple and may also be connected using one or more external clamps or ties (95, 112 in Figures 11, 12). The cells are made rigid pneumatically by a low pressure (such as about 7 psi) low volume air supply 61 (Figure 8) that is connected to the rails 41, 43. Cells are inflated by pumping air through passages 45 in the nipple. It may be advantageous to fill the cells with air that is exhausted by various pressurized systems on truck start up.

Referring now to Figure 9 a cross section of a portion of a rail 41 or 43 is shown. The rails can be made of aluminum or fiberglass and feature circular shaped nipples for mounting the air dam cells. A number of non-intersecting interior air passages 61, 63, 65 are made in the rail. Each passage supplies air to a finite number of nipples 50, such as ten nipples. The passages are independent from each other to minimize the potential for complete loss of air pressure should one cell malfunction. The rails are designed to be modular such that they may be placed individually for location optimization. Each rail and its interior air passages are in

communication with the pressurized air supply 61. Figure 9 shows the passageways arranged vertically, in another embodiment shown in Figure 10, there are four interior passageways 71, 73, 75, 77 equidistantly aligned side to side of the rail 41'. None of the passageways is located along the centerline of the rail, as this is where the nipples are mounted to the rail. Each of the four passageways begins where the rail is closest to the air supply such as at the front of the bullet shape as shown in Figure 9. The passageways 71, 73, 75, 77 have varying lengths and have holes that serve as an air conduit to a nipple 42. The holes start at the termination end of each rail. Each passageway has conduits for supplying ten nipples as shown in Figure 10.

Figures 11 and 12 show alternative air dam cell constructions. In Figure 11 a inflated bladder 97 makes up the air dam cell 90. The bladder is sealed to a nipple 93 on a mounting rail 92 that does not include air channels. The bladder retains air present in the bladder during installation due to the clamping force of a clamp 95 that holds it to the rail. In this embodiment, the bladder is flexible enough to deflect under impact and is easily replaceable. Figure 12 shows yet another embodiment in which an air dam cell 110 is made up of a flexible sleeve 117 held to a mounting rail 113 with a clamp 114. Similarly, the flexible sleeve can deflect under impact while providing sufficient wind deflection when placed adjacent other sleeves in the air dam system.

As can be seen from the foregoing description, an air dam made up of flexible cells that can be moved into and out of position can provide aerodynamic benefits to a vehicle as well as an air dam system with improved impact resistance. The location and shape of the installation on the vehicle in front and under-carriage banks allows for the air dam to be installed around the entire periphery of the vehicle including the trailer. The air dam system has the additional benefit of being less visually intrusive to the design of the vehicle.